to constitute atmospheric air; but when combined with oxygen, forming several compounds, amongst which is *nitric acid* or *aqua fortis*; this combines with most metallic oxides, and forms an important class of compounds called *nitrates*.

Oxygen, a non-metallic incombustible gas, but a powerful inducer and supporter of combustion; it is universally present throughout nature, in air, in water, in earth, and most organic bodies. Its compounds with other elements, when not acid, are termed *oxides*, thus, all the substances formerly called earths or calces, are true oxides of metals.

Aluminum, *calcium*, *magnesium*, and *silicium* are metals obtained from clay, or alumina, lime, and magnesia, and *silica*; they are extremely difficult to procure, on account of their extraordinary affinity for oxygen; hence, in a pure state, they are not practically known, but their compounds are of vast utility and interest.

Iron, a metal most abundantly presented throughout nature in a state of combination, and especially with oxygen. It forms two *oxides*, and these are capable of combining with various acids to form compounds, which constitute the basis of many colours and stains: it is a metal having a very extensive and practically valuable range of chemical affinity.

Potassium and *sodium* are the metals of the alkalies potash and soda. These metals are difficult to obtain on account of their energetic affinity for oxygen, and they are only of importance in the refined operations of analytical chemistry; but their compounds with oxygen, and of these with other oxides and acids, are of great value in most departments of science, art, and industry.

Many of the metallic elements are employed in a pure or insulated state, as, for example, iron, copper, tin, lead, or zinc; in the form of beams, bars, rods, sheets, tubes, and pipes of all sizes, shapes, diameters, and thicknesses.

The compounds which some of the metals form with each other are technically called *alloys*; these are in universal request in decorative architecture; for example, bronze, and brass; the former a compound of copper and tin; the latter, of copper and zinc. The hard and soft solders, also, used for uniting the several parts of metallic work, are all alloys of various metals. These alloys, generally speaking, are more fusible than the individual metals of which they are composed, and, therefore, admit of being applied with great facility.

The precious metals, gold and silver, are employed in decorative architecture even to a lavish extent. But the great value of these elements would entirely preclude their use if they did not possess the important physical property of malleability, or extension into leaves of extreme tenuity, in a degree superior to all other metals; for as regards gold it may be stated, that a cubic foot of the precious metal admits of being beaten into leaves sufficient to cover nearly one hundred thousand square yards. Then the permanence of gold, and good gilding, is remarkable. It has no affinity for oxygen, or any other substances that are existent in air or in water; it, therefore, preserves its deep orange lustre unimpaired for centuries,—witness, for example, the golden ornaments and the gilding that embellish the cases of Egyptian mummies. Silver, on the other hand, although of a beautifully chaste white lustre, will soon become tarnished or dull. This change is not due to oxidation, but to the action of sulphureous vapours upon the metal, by which a thin scale of sulphuret of silver is formed, and this acts as a shield to the metal beneath. The silver and silvering found in many ancient cathedrals, churches, and abbeys, is frequently thus tarnished, or blackened, and to a very great extent, if in the immediate vicinity of decomposing organic bodies.

The use of silver is almost excluded from theatrical decorations and properties, unless it be strongly lacquered, to keep off the action of the sulphureous compounds which are emitted during the combustion of coal-gas, and very few silversmiths or jewellers can venture to illuminate their shops with coal-gas unless great care has been taken in its purification. It is no easy task to free gas entirely from compounds of sulphur, hence the recent plan of having the gas lamps outside, instead of inside the windows, to exclude the action of sulphur, and also the heat, and watery vapour, resulting from the combustion, all of which conduce to the tarnish.

The chemical habitudes of the metals require much study from the architect, for a metal alone may be extremely permanent, but will often corrode rapidly if in contact with another metal; thus, for example, copper or zinc, alone, will resist oxidation for a great length of time, but let them be rivetted together, and exposed to the vicissitudes of the atmosphere, and the zinc will soon sustain corrosion. The chemist discovers that the mere contact of dissimilar metals disturbs their electrical relations, thus zinc renders copper electro-negative, and in that state it will not suffer chemical change, whilst the zinc becomes electro-positive, and in that state, although capable of protecting the copper, suffers oxidation and corrosion itself.

This fact having been pointed out by the chemist to the architect and builder, we now find when plates or masses of metals are to be employed, care is taken to examine strictly their electro-chemical relations or habitudes, that corrosion may be prevented, though in many cases the fact cannot be conveniently rendered applicable. Look, for example, at railings of cast, but more especially of wrought-iron, when firmly secured into stonework by pouring molten lead around them, how often they decay and dwindle away in some cases to mere wires, especially at their lower parts, immediately in contact with the lead, the iron being rendered electro-positive, and therefore capable of undergoing oxidation by the joint agency of air, water, and the animal fluids that are so commonly voided against corner rails. Although the common metals, *ex. gr.*, tin, copper, lead, iron, &c., are so extremely plentiful and cheap, they are not presented by nature either in purity or quantity adequate to the supply of the enormous demand that is made for them in the arts of life, and as they are all elements, of course the chemist cannot form them artificially. The metals are presented by nature in combination with non-metallic elements, generally oxygen and sulphur, constituting *oxides* and *sulphurets*, or as oxides combined with acids, constituting *carbonates* and *sulphates*; such compounds are known to the chemist under the title of *metallic ores*. Thus the tin ore of Cornwall is an *oxide*, whilst the copper ore of that county is a *sulphuret*, and the iron ore of Staffordshire is a *carbonate*, these are familiarly known as *tin-stone*, *copper pyrites*, and *iron-stone*; they contain the metals, tin, copper, and iron; the art of obtaining such valuable forms of matter is founded upon known laws of chemical affinity, and consists in exposing the respective ores to heat, with some non-metallic element, having a strong affinity for that in the ore, but none for the metal; this operation is called *reduction*, and during its procedure the metal is *not made* or *produced* by the agents employed, but *drawn forth* or *educed* from its natural combination with a non-metallic element.

The following example may serve to explain the theory of the process of reduction. If a piece of charcoal be heated red hot, it will rapidly consume; this is a chemical change and due to the charcoal or its pure *carbon*, exerting affinity for the *oxygen* of the surrounding air, so that the product of the combustion is *carbonic acid gas*; the chemist ascertains by analysis, that the ore of tin consists of the metal and oxygen, and having as in the above simple instance discovered that charcoal at a high temperature has an affinity for oxygen; he mingles charcoal with the ore of tin, and expects upon heating the mixture in a furnace, that the charcoal will burn by attracting the oxygen of the ore, that carbonic acid will be *produced*, and then the metal thus deprived of oxygen or *deoxidated* will be *educed*; the correctness of this reasoning is borne out by experiment, and conducted upon a large scale it furnishes all the commercial demands for the metal tin.

The natural and artificial compounds of oxygen with the metals present a vast mass of useful materials for the purposes of the architect and the builder. All of these have been laboriously and accurately examined by the chemist.

Thus pure white clay, sand, and lime, although commonly called *earths*, are true *metallic oxides*, the constituent metals being so firmly united to oxygen by the power of chemical affinity, that they do not admit of extraction or reduction by ordinary decomposing agents, but by employing such, in conjunction with the action of electricity, three extraordinary metals, viz., *aluminum*, *silicium*, and *calcium*, reward the researches of the experimentalist.

In consequence of clay, sand, and lime, undergoing no reduction to the metallic state by the sole agency of heat, they become eminently fitted for the construction of fire-places and furnaces, not only for the combustion of fuel for warming dwellings, but for that required in the reduction of ordinary metallic ores and the formation of every variety of earthenware, porcelain, glass, and vitrifications, as will be more particularly shewn hereafter. Native compounds, or in some instances, native mixtures, and in others artificial mixtures of these substances with other metallic oxides, constitute all the varieties of granite, slate, terras, puzzolano, and cement. Oxide of iron is most abundantly distributed throughout nature, and more particularly in all common kinds of clay, it has a very intense affinity for the pure white alumina of clay, and the red colour of bricks, tiles, and articles of common pottery is referrible to its presence in a high state of oxidation induced by the heat and air of the clamp or kiln in which such useful materials are burned or baked. Then the chemist by attentively studying the characters of ordinary metallic oxides, finds that they have the power of uniting with those used in the manufacture of earthenware, and of conferring various splendid and highly permanent colours, thus the oxides of chrome, cobalt, and manganese, respectively confer all shades of green, blue, and purple.

The glass employed in window-sashes is a compound of metallic oxides, crown-glass, for instance, consisting of oxide of silicium or *silica*, and oxide of sodium, or *soda*; whilst the softer and more brilliant glass called flint-glass consists of silica oxide, of potassium, or *potash*, with the addition of litharge, or *oxide of lead*; to this its extreme brilliancy and high refractive power are referrible, and hence its admirable adaptation to the splendid cut-glass chandeliers, lustres, &c., which are introduced by the hand of decorative art. All the beautiful varieties of stained glass are compounds of metallic oxides; and seldom, indeed, do we imagine, when gazing upon, and admiring the effect of the beams of rainbow-coloured light that pierce through the party-coloured panes of a magnificent cathedral window, that the glass, under the hands of the chemist, may be caused to reveal more beauties that those immediately apparent to the eye; but such is the case, for the deep ruby red is conferred by gold, the bright yellow by silver or antimony, deep orange by iron, green by iron or copper, blue by cobalt, purple by manganese, and the various shades of colour by the judicious admixture of those metallic preparations with each other in originally colourless glass, the same as various shades may be produced by adding ordinary pigments to white lead upon the palette of the artist,—with this exception only, that vitrified colours will never fade or deteriorate; witness the vitreous relics of Egyptian art.

Pursuing our inquiries regarding "Chemistry as applied to construction," it appears that all kinds of mortar essentially consist of oxide of calcium and oxide of silicium, or, in other words, lime and sand; whilst hydraulic cements, which harden or set under water, contain, in addition, oxide of aluminum, or alumina, and oxide of iron. These latter substances confer the peculiarity belonging to such cements, in consequence of a very powerful and beautiful affinity that is brought into action when they are mingled with the materials of common mortar. This important subject will open a wide field of discussion. Oxide of calcium, or lime, naturally combined with carbonic acid, and in many cases involving other metallic oxides, presents the architect and the builder with every variety of pure white and veined marble, free-stone, Bath-stone, lime-stone, calcareous spar, chalk, and whiting.

In the language of chemistry, the combination of an oxide with an acid is called a *metallic salt*, however it may differ in its character from common salt, which is a binary compound of chloride of sodium.

Alabaster, gypsum, plaster-stone, and plaster of Paris, consist of sulphuric acid and lime, and are more or less pure according as they

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